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Climate for women in climate science: Women scientists and the Intergovernmental Panel on Climate Change

Citation for published version:

Gay-antaki, M & Liverman, D 2018, 'Climate for women in climate science: Women scientists and the Intergovernmental Panel on Climate Change', *Proceedings of the National Academy of Sciences (PNAS)*, vol. 115, no. 9, pp. 2060-2065. <https://doi.org/10.1073/pnas.1710271115>

Digital Object Identifier (DOI):

[10.1073/pnas.1710271115](https://doi.org/10.1073/pnas.1710271115)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Proceedings of the National Academy of Sciences (PNAS)

Publisher Rights Statement:

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Correction

ENVIRONMENTAL SCIENCES

Correction for “Climate for women in climate science: Women scientists and the Intergovernmental Panel on Climate Change” by Miriam Gay-Antaki and Diana Liverman, which was first published February 12, 2018; 10.1073/pnas.1710271115 (*Proc Natl Acad Sci USA* 115:2060–2065).

The authors note that the following statement should be added to the Acknowledgments: “We would like to thank all who responded to the survey. This research was partially funded by a grant from the Agnese Nelms Haury Program in Environment and Social Justice.”

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Published online March 19, 2018.

www.pnas.org/cgi/doi/10.1073/pnas.1803793115

Climate for women in climate science: Women scientists and the Intergovernmental Panel on Climate Change

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Edited by Susan Hanson, Clark University, Worcester, MA, and approved January 17, 2018 (received for review June 6, 2017)

The Intergovernmental Panel on Climate Change (IPCC) is an authoritative and influential source of reports on climate change. The lead authors of IPCC reports include scientists from around the world, but questions have been raised about the dominance of specific disciplines in the report and the disproportionate number of scholars from the Global North. In this paper, we analyze the as-yet-unexamined issue of gender and IPCC authorship, looking at changes in gender balance over time and analyzing women's views about their experience and barriers to full participation, not only as women but also at the intersection of nationality, race, command of English, and discipline. Over time, we show that the proportion of female IPCC authors has seen a modest increase from less than 5% in 1990 to more than 20% in the most recent assessment reports. Based on responses from over 100 women IPCC authors, we find that many women report a positive experience in the way in which they are treated and in their ability to influence the report, although others report that some women were poorly represented and heard. We suggest that an intersectional lens is important: not all women experience the same obstacles: they face multiple and diverse barriers associated with social identifiers such as race, nationality, command of English, and disciplinary affiliation. The scientific community benefits from including all scientists, including women and those from the Global South. This paper documents barriers to participation and identifies opportunities to diversify climate science.

climate science | women in science | IPCC | climate change | intersectionality

The Intergovernmental Panel on Climate Change (IPCC) has become the authoritative scientific voice on climate change since its first report in 1990 (1). Several studies have examined the demographics of authorship of the IPCC reports and have shown that authorship leans toward the natural sciences, the more developed countries, nonindigenous voices, and men. These studies suggest that this bias could challenge the representativeness, legitimacy, and content of the reports if they fail to adequately incorporate the scientific expertise of developing countries, indigenous knowledge, a diversity of disciplines in natural and social sciences, and the voice of women (2–7).

Gender, Science, and Intersectionality

Many studies have documented the gender imbalance in science and have explored the reasons that women are not included or represented, especially at more senior levels of research (8–13). A 2013 special report in the journal *Nature* concludes that, despite some improvements, female scientists continue to face discrimination, unequal pay, and funding disparities and notes that, internationally, 70% of men and women view science as a male pursuit (14). Women face barriers associated with their family responsibilities and are poorly represented in journals and citations (15–18). Including women in research teams enhances innovation and discovery (19–21). Claims about data and explanations of women's underrepresentation in science can be controversial with some suggesting women choose to not pursue

a career in science and others recognizing more structural causes (17, 22–24). In our own discipline of geography, several studies have identified barriers facing women in physical geography including the masculinist culture of fieldwork, lack of role models, and family responsibilities (25–29).

A more nuanced understanding of difference can be found through “intersectionality,” a term coined by Crenshaw to show how social categorizations (e.g., gender, race, ethnicity) are dynamic and, often in combination, serve as grounds for inclusion and exclusion in our social fabric (30). Feminist inquiries see gender as a constructed analytical category within which humans think about and organize their social activity, rather than as a natural consequence of sex difference. In the same way, we can begin to appreciate the extent to which sexism, racism, classism, and cultural imperialism restrict the life opportunities of individuals and thus their contribution to science (31). These multiple exclusions have been proven to undermine the quality of scientific knowledge, job satisfaction, and career advancement (13, 20, 32–35).

An intersectional approach has been used to understand how multiple roles and identities contribute to vulnerability to climate impacts. Characteristics such as gender, socioeconomic status, ethnicity, nationality, health, sexual orientation, age, and place can disadvantage or empower in experiencing and responding to climate change and environmental problems (36–40). Gender is now a reviewed research topic for the IPCC because of the differential impacts of climate change and climate policy on women [e.g., in chap. 13 of the Working Group II IPCC fifth assessment (41)]. Poor representation of women decision makers has been

Significance

Women in science face barriers to professional advancement. One of the most important forums for international climate science is the Intergovernmental Panel on Climate Change, where there has been a slow increase in the proportion of women authors since the first assessment in 1990. Our survey of more than 100 female Intergovernmental Panel on Climate Change authors explores their experience and perceptions, the barriers to their full participation that they identify, and recommendations for improvements. While we find that some women reported a positive experience, others felt women were poorly represented and heard and encountered barriers beyond their gender including race, nationality, command of English, and discipline. The study contributes to the larger literature on gender and science and provides recommendations for greater inclusion.

Author contributions: M.G.-A. and D.L. designed research; M.G.-A. performed research; M.G.-A. contributed new reagents/analytic tools; M.G.-A. and D.L. analyzed data; and M.G.-A. and D.L. wrote the paper.

The authors declare no conflict of interest.

This article is a PNAS Direct Submission.

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Published online February 12, 2018.

To what extent does your most recent experience agree or disagree with the following:

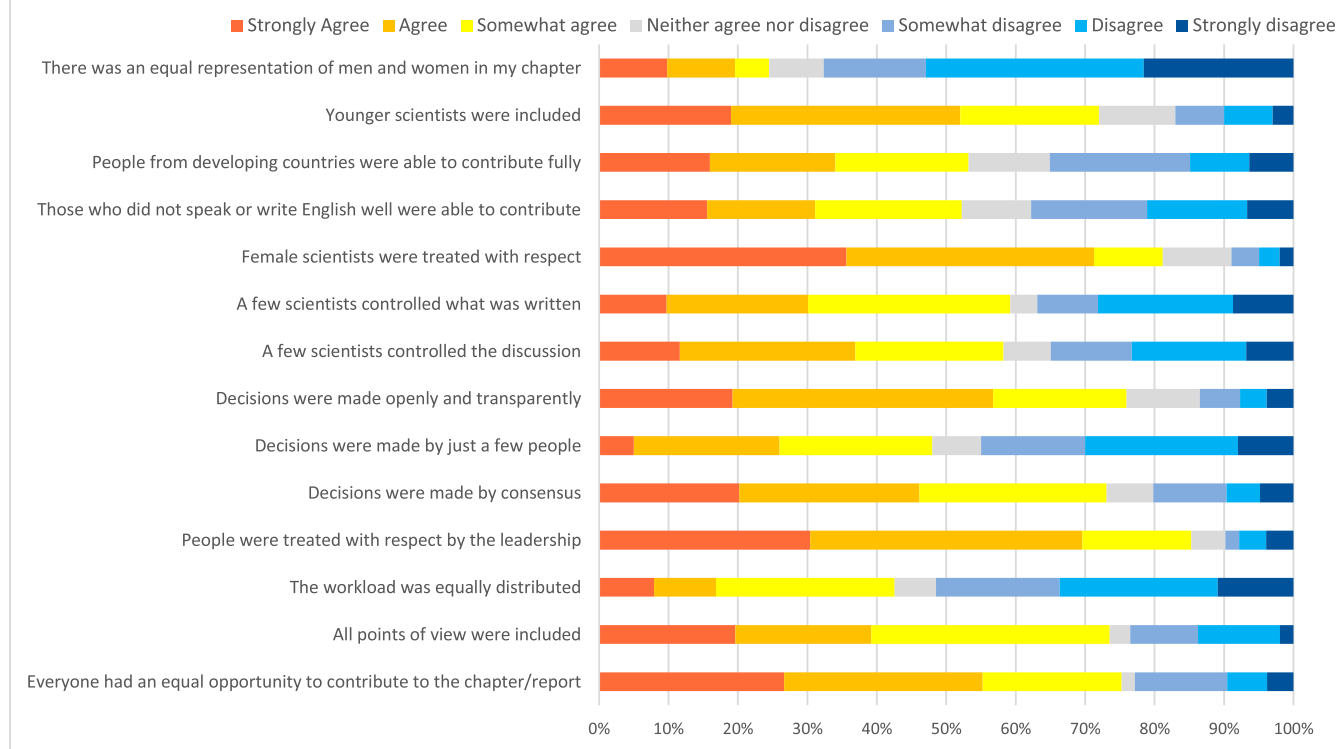


Fig. 1. Most recent experiences participating in the IPCC.

some of the difficulties that I think that some of the developing country representatives must have.” Seventy-five percent saw lack of English ability as a barrier for others, 37.5% saw gender as a barrier for others, and 28% perceived a barrier for others associated with race. The open-ended responses were numerous in identifying women from developing countries as marginalized.

Many respondents commented that one of the most important tools for success in the IPCC was a good command of spoken and written English: “I found that in many instances having a good English command and speaking out loud defined a discussion.” English as the dominant language for all working groups of the IPCC (with the exception of some regional chapters), excludes those with imperfect command of English while gives greater voice to native English speakers and those with degrees from English-speaking institutions. One scientist commented “having earned my PhD in an English-speaking country, I have good speaking and writing skills. Without those aspects, my participation would have been a lot more frustrating, as I could observe with other female Latin-American colleagues.”

Some women noted that gender was an issue in holding leadership positions. For example, one respondent noted: “It seemed very difficult for some of the men in my chapter to accept that a woman was leading them. Women were rarely given the word; our suggestions were almost never taken up.” Others noted their multiple intersecting challenges: “in my case, I think it was the factor of: gender + age + command of English” and “being a woman and not particularly tall or loud, I found myself struggling to get attention from ‘senior’ scientists at meetings.” An intersectional lens highlights how individuals often experience discrimination based on social signifiers such as gender, race, class, and sexuality at the same time. These are not discrete categories but intersect; thus, a scientist who is a woman of color and small stature and from a developing country may face multiple levels of discrimination (30, 63).

Although most respondents reported little discrimination based on race, 35% of women of color reported race as a barrier to their full participation. As one African woman expressed: “The only reason that I could have felt not required at all in the team could be that I am an African woman. I have very good command of English, I am as qualified as others, I am confident also—but I was never listened to.”

A third of respondents reported that childcare and family responsibilities were barriers to their full participation in IPCC (Fig. 3). Women noted that if they had children, childcare responsibilities were their biggest obstacle, particularly those who were single parents or with babies. Several confessed that this responsibility might have negatively impacted their performance during the IPCC; as one noted, “I was a single parent during the last IPCC cycle, so traveling was a major obstacle. I managed because I really wanted to do this, but it was a large extra hurdle that caused me to arrive stressed at meetings and sometimes to not have full attention.”

Almost two-thirds saw a lack of time as a major barrier, and 21% had problems with lack of financial support from their country and/or institution for travel. The considerable time devoted to being a responsible IPCC author was a challenge, especially for less senior scholars: “One issue is the fact that being an IPCC author comes on top of other professional duties (research, teaching, administration, meetings) with extra work, travel to remote places, and with a timeline that is sometimes totally incompatible with the usual rhythm: report versions to be delivered during summer break or at the end of winter break, which are usually to spend with family.” Some women did not receive support from their supervisors and had to take vacation time to participate: “I was under a lot of pressure not to participate” or “There was retribution against me by others where I work because I chose to participate.”

Time needed for the IPCC is a particular problem for early career authors. While IPCC authorship can be helpful in increasing

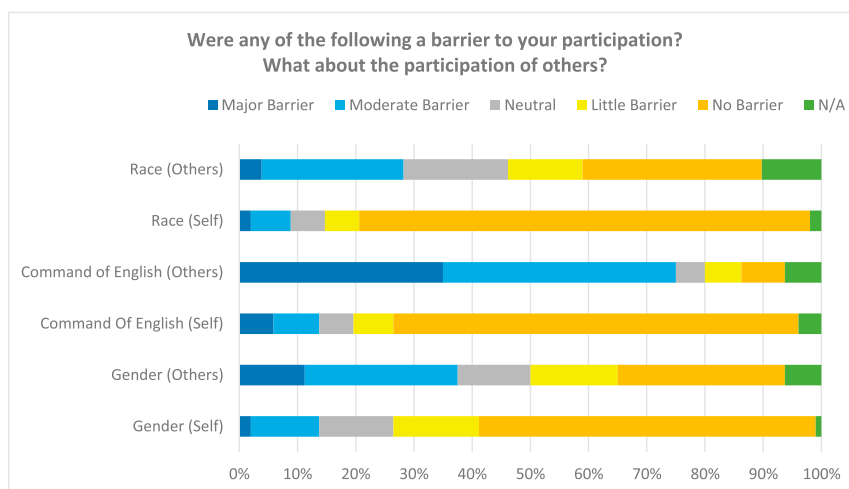


Fig. 2. Barriers to participation considering race, gender, and command of English: respondents' view of their experience and their perceptions of that of others.

one's national and international reputation, it may not increase your publication record: "for junior colleagues the barriers included a reduction in their publications given the large amount of time the process takes over the course of the 2-y cycle. The loss of individual productivity could influence their advancement in academe, which does reward publication over service, regardless of its importance." One woman reported that as a younger author "I was petrified, and often silent in author meetings."

We note that IPCC authors do not receive any payment for their work. A few women reported that participation resulted in

a significant reduction of income, and others reported having to take vacation days to work on the IPCC because of basic incompatibility with their regular work schedules or lack of understanding from their supervisors. This reflects common barriers facing women in the workplace (66). Women do most of the housework, including childcare, and this is consistent around the globe with women working 2 h more per day than men in the United Kingdom, 1.5 h more than men in France, and 4.3 h more than men in Mexico (18). This leaves little time for voluntary duties such as the IPCC on top of family and work responsibilities.

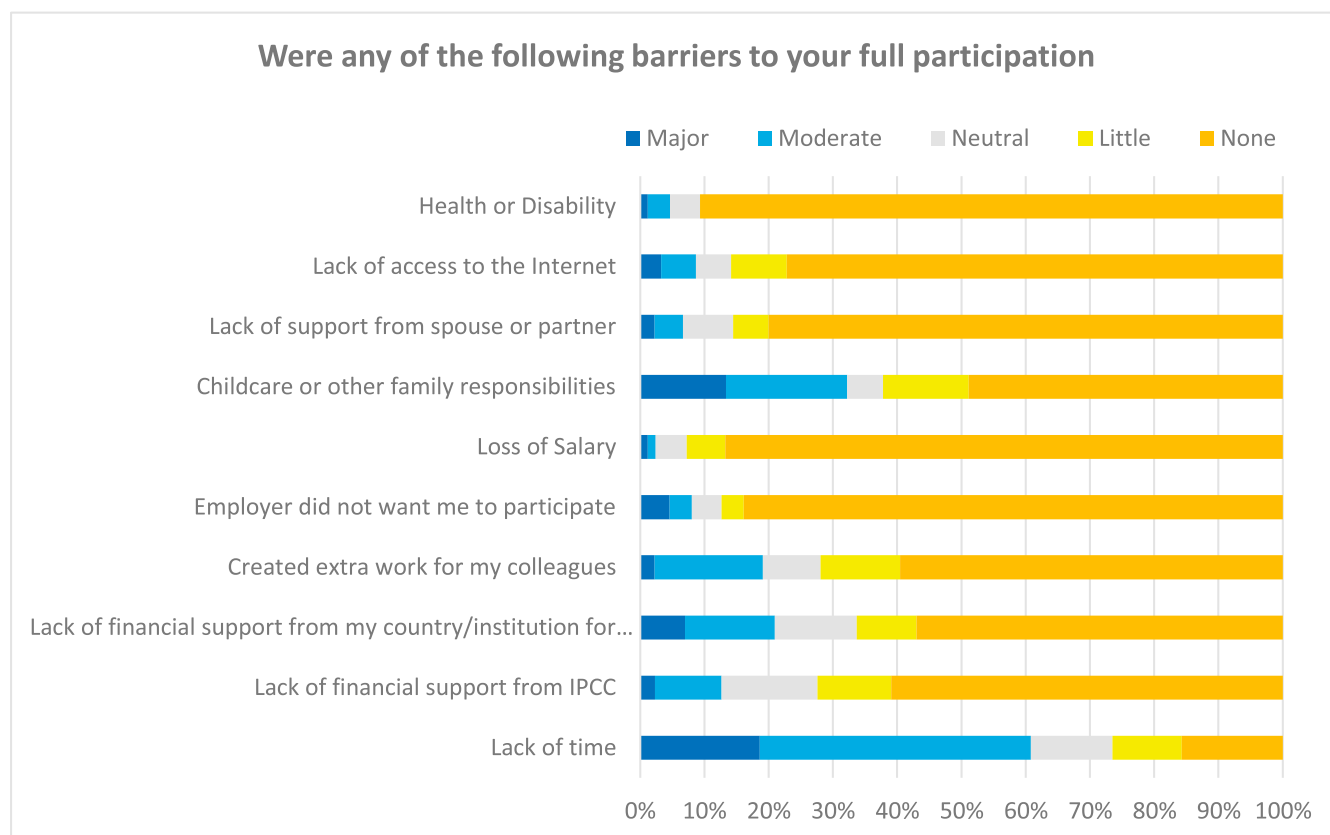


Fig. 3. Barriers to participating and influencing the IPCC report.

Gender and Climate Science. Finally, we asked survey participants specifically about the role of gender in being a climate scientist. Forty-one percent of women saw gender as a barrier to their success, and 43% believed that female climate researchers are not well represented in the climate community. The open-ended responses to these questions provide insights into the different types of discrimination based on gender that might include active discrimination, subtle discrimination, and discrimination based on family responsibilities.

Active discrimination occurs when women are not included, silenced, ignored, not supported, or not given the credit that they deserved because they are female. As a respondent noted, "There are enough female scientists that are capable of contributing . . . [but] males promote other males. It is a fact that there are many male scientists in IPCC that discriminate against female scientists based on the simple fact that they are women." Another told us "women are still not listened to as much in committees. Many times, a male colleague repeated what I'd just said, and it was then tagged in the future as (his) idea rather than mine."

Subtler discrimination was reported when women recognized that gender must have been a barrier in their career as scientists but were unsure of how or when it happened. For example: "I suspect that gender has delayed my career, it's hard to say exactly how, but probably through lack of mentoring, not being 'seen.' . . . I now have a full professorship, but I still feel that a male of the same standing might be more likely to be picked for a leadership role than I would." Another woman wrote "in my view being a female scientist is never neutral. Mostly it is detrimental, people do not take you seriously when you speak. . . . Rarely do I feel just 'normal,' only with very close colleagues." Some attributed their success to good luck because they saw many of their female colleagues' struggle. One expressed the following: "While I have been lucky in my career opportunities, I see many of my female peers dropping out along the way due to lack of job security and flexibility, which impacts females more than males."

Discussion and Recommendations

Women in the IPCC are among the world's most recognized climate scientists yet their responses to this survey suggest that gender, especially when combined with race, nationality, family responsibilities, or language, are important barriers for their and other women's full participation in climate science and assessments. Several women reported that they adopt traditionally male characteristics to be heard, such as being loud or exhibiting high confidence. Women often have to struggle to make their voices heard and overcome barriers (11, 67). Our survey indicates that barriers are greater for women with young children, for women of color, and for those from the developing world. These power differences generate particular types of knowledge and can influence the tone and content of assessments.

To be sure, some of the barriers identified by women in our survey are also experienced by men, especially those men who have problems with English fluency, racism, family responsibilities, or lack of time.

Many of our respondents made suggestions on how to improve the experience of women participating in the IPCC, including:

Encouraging remote participation via videoconferencing or phone calls to decrease the burden of travel.

Asking IPCC leadership to invite more women, and governments to nominate more women, to increase the pool size of qualified candidates.

Ensure that women have travel support or pay to compensate for using vacation.

Creating a support network for women involved in the IPCC to actively connect with each other.

Finding ways to be more family friendly (e.g., childcare, remote participation, timing of meetings) so that women do not

have to choose between participating in the IPCC or having a family.

Pay attention to gender concerns in meetings and in report content on climate impacts and responses.

Increase the proportion of women in leadership positions.

Invite younger women to participate as observers or chapter scientists.

Require training on gender issues to raise awareness of how to be gender-sensitive and open to different methods of encouraging full participation.

Monitor perceptions of participation throughout the process through evaluations that would highlight any barriers and allow for adjustment.

Ensure that women authors are included in synthesis reports and summaries for policy makers, reports to the Conference of the Parties, and relevant publications resulting from IPCC reports.

Make English language editors or translators available to overcome language barriers.

Compensate for accumulated discrimination by selecting women even if it means that some may have a slightly less impressive publication list than their male counterparts.

Recognize the multiple sources of discrimination and lack of voice that include gender, race, language, national origin, age, and other challenges.

Some of these recommendations are already being addressed by the IPCC. For example, the Special Report on 1.5C has 38% women authors, and there are now more women in leadership positions. IPCC authors are leaders in science, able to inform policy, and recognized globally as when the IPCC received the Nobel Prize for Peace in 2007. Role models are important to young aspiring scientists (68, 69), and women climate scientists can give voice and equal power and recognition to the half of the world that is female. Increasing the participation and voice of diverse women in the IPCC—especially those of color and from the developing world—will not only promote fairness and increase representation, but also can result in better and more influential climate science.

Materials and Methods

All methods and materials were reviewed and approved by the Institutional Review Board (IRB) at the University of Arizona. Participants were presented in writing with the same information required in a written consent document, but signing of the consent form was waived by the IRB. The research involves no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required. Our goal was to survey as many women as we could identify who had been a coordinating lead author or lead author of an IPCC report. We chose to survey only women because we were interested in their experiences and views rather than a comparison with men. Identifying female IPCC authors is challenging because the first two assessments identified authors only by their initials and did not distinguish lead authorship. Some women could not be located. After undertaking a pilot survey and removing duplicates of women who served in multiple roles and reports, we contacted 223 individuals by email asking if they would complete a web survey. A total of 111 responded to some questions, and 98 completed the full survey—a response rate of 44%. We asked both closed and open questions to understand (i) the basic demography, (ii) views of the IPCC author experience and impact on her professional career, (iii) perception of barriers to their participation and voice and those of other women, and (iv) recommendations to improve women's participation in the IPCC. We report both quantitative and qualitative results with illustrative quotations to give voice to our respondents.

ACKNOWLEDGMENTS. We wish to thank the Editor and Reviewers for their helpful comments and suggestions. M.G.-A. thanks Dave Rockoff for the helpful discussions.

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